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This invention covers the procedure and equipment for the transfer of above ground information to an underground information receiver located in the borehole, as described in requirements 1 through 7.

In a similar, well known procedure (patent no. US-A-5,332,048), the operation is based on the sequential switching on and off of the mud pump, thus changing the volume of the flow of the flushing mud. In this procedure, the sensor is operating as flow switch that transfers the information to the receiver whether the flow of mud is being switched on or off; the receiver then utilizes these on/off signals based on the timeliness of their sequence. The information transferred and utilized in this procedure triggers a further reaction if required, such as the changing of the direction of the directional drilling equipment.

By subsequently switching the mud pump or pumps on and off again, these pumps and the drives in them are subject to severe wear and tear. At the same time, the drill drive is also effected by the interruption of the drilling procedure during the transfer of information, resulting in a delay of the drilling procedure; this apparatus, however, accomplishes to decrease the down time of the drill head, despite the interruption. The process of information transfer may take considerable time, depending on the volume of information to be transferred.

The goal of this invention is to provide precise data transfer to the downhole data receiver with minimal interruption to the drilling process, facilitated by the utilization of simple media that are basically free iof wear and tear.

In this invention, the solution to the problem is based on a procedure characterized by requirement no. 1, as well as a device characterized by requirement no. 7. In regrads to significant further elaboration, reference is also being made to requirements nos. 2 through 6, as well as nos. 8 through 16.

The procedure and the device subject to this invention leave the mud pump and/or pumps unchanged during the transfer of information, having it/them operate under optimal conditions at all times. The alteration of the constant bulk stream produced by the mud pump, without altering the pumping action, makes it possible to affect changes in the bulk

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Fig. no. 4: illustration of the course of the pulse of a bulk stream change implied by the invention, at the time of the signal transfer;

Fig. no. 5: a modified version of the course of the pulse, and

Fig. no. 6: a diagram illustrating the winding voltage of the generator, as shown in relation to time.

Fig. no. 1 illustrates a drill equipment used for the drilling in underground formations with a drill tower (1) that provides support and drive to a bore axle (2), furnished with a flush head (3) at its top extremity, and with a drilling tool (4) at its bottom extremity, respectively. The drilling tool in the bore hole (5) has a housing (6), stabilizers (7 and 8), and a field (9) with controlled stabilizing ribs which can be moved in and out. The field (9) can be rotated around the tool axle (11) relative to the housing (6), and is mounted with bearings to the latter; during operation, it is arranged in the bore hole (5) in such a way that it won't turn. At the same time, the drilling tool (4) may be shifted into turning, together with the drill head (12), such as a bore chisel or a roll chisel, by means of the bore axle (2).

The drill equipment also has a flush fluid tank (13) that is only schematically illustrated. This tank contains a reserve flush fluid container (14), one (or several parallel connected or serial connected) flush pump(s) (15) whose injection nozzles reach 15' into the reserve flush fluid container, a connection line (16) that connects the flush pump (15) with the flush head (3), as well as a return line (17) that is connected to a collector (18) in the bore hole head and flows into the flush tank (13). Flush fluid is transferred from the ring groove (19) between the wall of the bore hole and the bore axle (2) through the return line (17).

When in operation, the flush pump (15) circulates the flush fluid (14) in the direction of the arrows (20) from the flush fluid tank (13) downwards through the inside of the bore axle (2) and of the drill head (12), then continuing in the direction of the arrows (21) upwards through the ring groove (19) between the bore axle (2) and the bore hole wall, returning finally to the flush fluid tank (13). The flush pump (15) is propelled by the schematically illustrated drive (22) with constant output, transporting flush fluid (14) to the connecting line (16) accordingly, with non-fluctuating bulk stream.

pump, without altering the pumping action, makes it possible to affect changes in the bulk stream in the positive direction which are independent from the switch-on / switch-off position of the pump(s) and rely solely on technical parameters of the data transfer. During the period of data transfer, the circulation of the flushing fluid remains constant, with the volume of its flow barely fluctuating; this guarantees the removal of the drill residue from the drilling area of the drill head as well as the cooling of the drill bit. Therefore, the drilling procedure continues without any interruption even during lengthier periods of data transfer. The frequency, amplitude and the flank shape of the switch pulses that influence the flow of flush fluid, may be selected at random or even interconnected; this guarantees a reliable transfer of information even if at the same time with the above mentioned data transfer to a downhole receiver, information is being transferred to an above ground information receiver from a downhole source.

The physical means necessary to achieve this consist of a simple power controlled branch line that operates practically free of wear and tear, and a measuring device that measures the bulk stream, the latter can also easily be added without any significant construction efforts. The construction of the bulk stream measuring device in form of a turbine installed on the bore axle, complete with a measurement result indicator which is a generator powered by the turbine, allows for a very precise registry of any changes in the bulk stream with minimal expenditure required, since the turbine and the generator may also be used to create underground voltage as may be needed to power electric or electronic sources.

Further characteristics and advantages of the invention are explained in the description and the drawing which shows an example of the model subject to the invention even in more details. The drawings contain the following details:

Fig. no. 1: a schematic sketch of a complete drilling equipment with blown-up details of certain parts;

Fig. no. 2: a detailed version of the modified execution of the control of the throttle mechanism in the branch line;

Fig. no. 3: a partial view through the drill bit in the area of the data receiver;

A branch line (23) that flows into the flush fluid container (13) is connected to the first line (16). This branch line is further connected to the turn-off mechanism (24) that can be operated either manually or by means of an appropriate working drive (25). This drive (25) is powered by an electronic control device (not included in figure no. 1), which can automatically trigger sequential changes in the bulk stream which is going to be described in detail later. The turn-off mechanism (24) can completely shut off the branch line (23), or it can allow for a partial stream of flush fluid, the direction of which is illustrated with the arrow (26). The turn-off mechanism (24) is further connected to a downstream throttle (27) which can predict the maximum change in the bulk stream that will be triggered by opening the branch line (23); this throttle is integrated into the connecting line (16) behind the point of junction, thus entering the circulation of the flush fluid.

The shut-off mechanism (24), as shown on figure no. 2, functions by means of a pressure operated drive (29) which sets the shut-off unit in motion. A check valve releases pressure agent such as compressed air from a container (31) into the drive. The check valve is connected to the container of the pressure agent (31) through two lines (32 and 33) with one line (33) containing a switch valve (34) that can be powered by means of an electronic control unit (35) which preferably consists of an electronic calculator, or contains one. The speed of the opening and closing mechanism of the shut-off unit (28) can be regulated by means of a regulating valve (30). At the same time, it is possible to achieve an intermediate position between the open and closed position of the shut-off unit (28).

The above described change in the bulk stream is preferably achieved above ground. However, it is possible to achieve the change in any of the areas downstream of the pump(s) if this is (these are) situated upstream of the underground sensor which records the change in the bulk stream.

In the above described example, there is a turbine (36) in the housing (6) of the drill equipment (4), fastened by the stream of the flush fluid in the bore axle (2). The lead ring (37) of this turbine is fastened to the housing (6), and its rotor (38) is held by a support (39) mounted to the housing (6) with a stator holder and an alignment structure (39) with two bearings (40 and 41), making it possible for the rotating propeller (42) to move around in the direction of the arrow (43). At the same time, the turbine rotor (38) that carries magnets (44) and turns around the windings (45) attached to the support piece (39), also serves as

the rotor housing for a generator. The exit voltage is conducted over an electric connection line (46) near a schematically illustrated electronic working unit (47), which is at the same time also the data receiver and can serve as part of an electronically controlled unit of the directional drilling tool (4).

In order to induce a data transfer procedure of above ground information to the downhole information receiver (47), the turn-off mechanism (24, 24') needs to be activated by opening the branch line (23) while the drilling is being continued in full force. This creates a decrease in the bulk stream of the flush fluid in the drill axle (2) and also in the area of the turbine (36), resulting in a decrease in the RPM of the rotor (38) of the turbine (36). The above mentioned decrease in the RPM which is related in its proportion to the decrease of the bulk stream of the flush fluid, is interpreted by the data receiver (47) as a signal which may count the zero passages in the winding voltage diagram (48) shown in figure no. 6, measuared in relation to time by units of time. Figure no. 6 shows the winding voltage diagram in association to the y-axis (49), and the time in association to x-axis (50) of the coordinate system, while the time elapsed (51) represents a full rotation of the turbine/generator rotor (38).

By shutting the turn-off mechanism (24, 24'), the bulk stream of the flush fluid (14) is increased in the area of the turbine (36), which in return, results in the data receiver (47) interpreting the increase as a processed signal.

In lieu of the preferred combination of a turbine with a generator, which is being used in several cases as a source of power for downhole users, any other appropriate bulk stream measure equipment may be used. Also, instead of a general be used in association with the turbine, for example or centrifugal methods.

Flowrate ↗ MEASUREMENT EQUIPMENT

Depending on the way the turn-off mechanism is functionir it is possible to achieve a positive change in the bulk strean 4 in the form of the curve (52). This shows the change in the

The course and the angle of inclination of the pulse curve (5: speed with which the turn-off mechanism (24, 24') has bee

generator changes according to the change in the bulk stream, as illustrated in figure no. 5, which shows the voltage of the generator in relation to the time elapsed.

In order to achieve a change in the curve of the pulse, either one of the following may be changed: the time elapsed between the beginning and the end of the partial branch stream; the portion of the branch stream in relation to the total bulk stream of flush fluid transported from the flush pump (15); and/or the course of the time of starting and ending the branching off of the flush fluid. The changes in the bulk stream create mainly digitally coded signals, which may in return, cause any reactions that may be desired.

The data transfer is independent of the type of information to be transferred. Control signals for a directional drilling tool, as well as signals for the change of the type of operation of individual components of the downhole system, information about the bore procedure, stop and start signals directed to an above ground sender etc. may be transferred, thus creating a universal use for the data transfer which is the object of this invention. Constructing the control apparatus as an electronic calculator provides also the possibility of automatic exchange of information procedures by means of automatic reaction to the contents of the information received with the data.

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Patent Claims

1. Method of transfer of above ground information to a downhole data receiver, with special regards to a receiver device in a drill equipment, during the drilling procedure, with the following characteristics: at least one above ground flush pump is pumping flush fluid into the circulation downwards from a flush fluid container through the interior of a drill axle and of a drill head, and upwards in the ring groove between the drill axle and the drill hole wall and then on to the flush tank; the bulk stream of the flush fluid is changed during the data transfer procedure;the data receiver senses and evaluates the above change; distinguished by the feature that the bulk stream of the flush fluid activated by the flush fluid pump is being changed in an area downstream of the flush pump.

2. Method as per requirement no. 1. distinguished by the feature that the bulk stream is being changed by means of branching off a partial flow from the bulk stream of the flush fluid produced by the flush pump.

3. Method as per requirement no. 2, distinguished by the feature that partial flow branched off from the bulk stream returns to the flush tank.

4. Method as per one of the requirements 1 through 3, distinguished by the feature that time elapsed between the start and the end of creating a partial branch varies.

5. Method as per one of the requirements nos. 1 through 4, distinguished by the feature that the realation between the partial stream and the full bulk stream of flush fluid delivered by the flush pump varies.

6. Method as per one of the requirement nos. 1 through 5, distinguished by the feature that at the start and/or end of the creation of a branch stream, the portion of the separated partial stream in relation to the bulk stream may be increased from zero to maximum either steadily, or in several steps; likewise, it may be reduced from maximum to zero the same

way.

7. Equipment for the transfer of above ground information to a downhole data receiver (47), with special regards to a receiver device in a drill equipment (4), during the drilling procedure, with a flush fluid tank (13), with at least one flush pump (15), with a line (16) connected to the flush pump (15) at the upper extremity of the drill axle (2), and a sensor associated with the data receiver and reacting to the changes in the bulk stream in the drill axle (2); distinguished by the feature that the branch line (23) controlled by the shut-off mechanism (24;24') is connected to the above mentioned line (16).

8. Equipment as per requirement no. 7 distinguished by the feature that a bulk stream measuring device (36, 38, 44, 45) is being used as the sensor.

9. Equipment as per requirement no. 8 distinguished by the feature that turbine (36) fastened to the drill axle (2) by the flush fluid flow and situated in housing (6) of the drill equipment, whose rotor (38) is coupled to a measurement result indicator that captures its RPM, serves as a bulk stream measuring device,

10. Equipment as per requirement no. 9, distinguished by the feature that a generator (44, 45) powered by the rotor (38) of the turbine (36) serves as the measurement result indicator, whose exit voltage is in relation to the bulk stream.

11. Equipment as per one of the requierements 7 through 10 distinguished by the feature that the shut-off unit (28) of the shut-off mechanism (24, 24') in the branch line (23) can be activated by a drive (25, 29) which is controlled by an electronic device.

12. Equipment as per requirement no. 11 distinguished by the feature that a pressure operated drive (29) with a regulating valve (30) serves as the drive.

13. Equipment as per requirement no. 12, distinguished by the feature that the regulating valve (30) is connected to a source of compressed air (31), and there is a switch valve (34) associated with the electronic control (35) in the connecting line (33).

14. Equipment as per one of the requirements nos. 11 through 13, distinguished by the

feature that an electronic calculator serves as the control device.

15. Equipment as per one of the requirements nos. 7 through 14, distinguished by the feature that there is a throttle (27) in the branch line (23) downstream of the shut-off mechanism (24; 24').

16. Equipment as per one of the requirements nos. 7 through 15, distinguished by the feature that the branch line (23) flows into the flush fluid tank (13).

Summary

Procedure for the transfer of above ground information to a downhole data receiver (47) that is located in the drill hole (5), especially equipped with a receiver device in the drill equipment, during the drilling process, with the following characteristics: at least one above ground flush pump (15) is pumping flush fluid (14) into the system from a flush fluid tank (13) downwards through the interior of a drill axle (2) and a drill head (12), and upwards in the ring groove (19) between the drill axle (2) and the drill hole wall, continuing on to the flush fluid tank (13). For the transfer of data, the bulk stream of the flush fluid (14) needs to be changed, with the information receiver (47) sensing and evaluating this change. At the same time, the bulk stream of the flush fluid (14) produced by the flush pump (15) is being changed , by way of separating some of the flush fluid through a branch line (23) in an area downstream of the flush pump (14).

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